

Survey on some important functional foods from the Chinese and Eastern perspective

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Abstract. The functional food industry has been developing rapidly in recent years. The most important pharmacological properties of jujube are anti-diabetic effects, hypnotic-sedative and anxiolytic effect, neuroprotective activity, sweetness inhibitor, anti-cancer activity, antimicrobial activity, anti-ulcer activity, anti-inflammatory and anti-spastic effect, anti-allergic activity, permeability enhancement activity, cognitive activities, anti-fertility property, hypotensive and anti-nephritic effect, cardiovascular activity, immunostimulant effects, anti-oxidant effects, and wound healing activity. *N. nucifera* has various notable pharmacological activities such as anti-ischemic, antioxidant, anti-cancer, antiviral, antiobesity, lipolytic, hypocholestermic, antipyretic, hepatoprotective, hypoglycaemic, antidiarrhoeal, antifungal, antibacterial, anti-inflammatory and diuretic activities. Coix is a source of ornamental beads, a stable sustenance, and a productive fodder grass increasingly viewed as a potential energy source. The healing properties of lily include moisturizing the lungs, relieving cough from lung-dryness, clears heart-fire and tranquilizes the mind. Dried lily bulbs are commonly used in herbal formulas for promoting lung health, treating yin-deficiency of the heart which manifests as irritability, insomnia, dreaminess, palpitation and absent-mindedness, and promotes vital fluid and improves skin complexion. The most important tremella mushroom benefits are anti-aging, anti-inflammatory, lower cholesterol, combat obesity, protect nerves and may fight cancer. Functional foods are making inroads into Chinese diets with their promises to improve health and nutrition. Chinese consumers should choose nutritional and healthy food to maintain general health and reduce the risk of health problems.

Keywords: Functional Food, Jujube, Lotus, Coix, Dry Lily, Tremella.

INTRODUCTION

There are many parameters which influence functional food market and its potential in China. Functional foods and beverages are products with ingredients that are added for specific health benefits that are beyond basic nutrition. Food with function claims and nutrient supplements are both included in the system of classification and nutrient supplements are products intended to supply vitamins or minerals to replenish dietary insufficiency, defend against nutrition deficiency and reduce the risk of chronic degenerative diseases. Traditional Chinese medicine (TCM) has played a positive role in the management of so many diseases (Shahrajabian et al., 2019 a,b,c,d,e). TCM is an empirical healthcare system based on human experience dating back several thousand years and stands out as the only one with long history among the world's traditional medical system (Ge et al., 2018; Ogbaji et al., 2018; Shahrajabian et al., 2018; Soleymani and Shahrajabian, 2012a, 2018). The most important parameter is in providing healthy diets for the decades to come in a world with rapid population growth (Khoshkharam et al., 2010; Esfandiary et al., 2011; Shahrajabian et al., 2013, 2020 a,b,c,d,e; Soleymani et al., 2010, 2013, 2016; Soleymani and Shahrajabian, 2011, 2012 b c; Sun et al., 2019 ab, 2020). With increasing needs for a healthier life in Chinese society, functional foods are becoming more popular, while from the market perspective, functional foods are difficult to quantify because of different definitions which used in the world.

MATERIALS AND METHODS

All relevant papers in English language of various researchers and scholars from different countries were collected. The keywords of Jujube, Lotus, Coix, Dry Lily, Traditional Medicine, and Tremella were searched in Google Scholar, Scopus, Science Direct and PubMed.

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JUJUBE

The Chinese jujube (*Ziziphus jujuba* Mill.) which originates from China with a history of over 4000 years is recognized as the most important fruit species belonging to the Rhamnaceae family (Shahrajabian et al., 2019f). Chinese jujube (*Ziziphus jujuba* Mill.) and Indian jujube (*Ziziphus mauritiana* Lamk.) are largely used in traditional Asian medicine as super fruit. Indian jujube is known as ber, desert apple or Indian plum and it is a tropical/subtropical fruit native to the northern hemisphere (Pareek, 2013). Li et al. (2018) discovered that the Chinese jujube (*Ziziphus jujuba* Mill.) originates from sour jujube (*Ziziphus acidojujuba* Mill.) and is an economically important genus in the Rhamnaceae family. They also concluded that most jujube cultivars have a certain correlation with their origin and there are obvious gene exchanges between sour jujube and jujube cultivars. Its pulp is eaten mostly fresh, but may be dried or processed into confectionary recipes in bread, cakes, compotes, and candy (Krska and Mishra, 2008).

Jujube nutritional composition and chemical constituents

Chinese jujubes are lower in water content and titratable acidity and higher in total sugars (mostly reducing sugars) and phenolics. Chinese jujubes are very rich in ascorbic acid (vitamin C) content which increased with maturation to 559 mg/100 g fresh weight (Kader et al., 1982). Yan et al. (2014) found that five essential elements and two toxic elements (except cadmium) varied widely in their contents in the four jujube fruits. They announced that knowledge of the contents of these elements would provide consumers with information on the quality of jujube fruits. Chen et al. (2018) reported that the Junzao cultivar contained relatively low level on the total dietary fiber, protein, total sugar, and total titratable acids. The Huizao cultivar possessed the mediate level of the sugar-to-acid ration and ascorbic acid. The Dazao cultivar showed high level of the total dietary fiber, protein, sugar, and total acids. In their experiment, principal components analysis indicated that the parameters that differentiated these jujube cultivars appeared to be the total dietary fiber, protein, total sugar, fructose, glucose, sucrose, and total titratable acids. Rahman et al. (2018) noted that Chinese jujubes consist of 51.99–71.75% edible part, 82.35–89.63% carbohydrates, 4.43–6.01% protein, 0.48–0.63% lipid, 2.80–4.80% polysaccharide, 45.64–88.97 mg/100 g ascorbic acid, 132.16–196.58 mg/100 g phenolics and 101.17–132.04 mg/100 g flavonoids in dry matter. Ertop and Atasoy (2018) found that the jujube fruit is rich in mineral content, fiber and a good source of food for direct consumption and maybe a good additive for different foods when dried. In their study, they found that jujube fruit, especially in dried and

Table 1. Mineral composition of the seeds of *Ziziphus mauritiana* (Yerima and Adamu, 2011).

Content	Dry weight [mg/100 g]
Sodium (Na)	154.79±10.50
Magnesium (Mg)	6.23±0.12
Potassium (K)	589.08±10.69
Zinc (Zn)	3.52±0.05
Manganese (Mn)	1.15±0.14
Iron (Fe)	1.21±0.15
Phosphorus (P)	585.43±41.29

The values are means and standard deviations for three determinations.

powder form can be valorized in future studies as fortifier and hydrocolloid. Huang et al. (2008) also found that the fruits are nutritious, being high in flavonoids and vitamins C, B1, and B2, and because of that it can be considered as a so-called functional food, having nutritional as well as medicinal uses. Jujube as a nutritious fruit is important especially for low-income group people. Besides, it is grown successfully in unfertile land and drought prone areas. It is also a less perishable fruit and cultivating this fruit on a large scale can economically benefit farmers. Mineral composition of seeds of *Ziziphus mauritiana* is shown in Table 1.

Traditional medicinal uses and potential health benefits of jujube in modern medicine industry

The jujube leaf, which is the main byproduct of jujube, has also been used in TCM for thousands of years to improve sleep, to nourish the heart and soothe the nerves, and to reduce hemorrhaging and diarrhea (Goetz, 2009; Motevali et al., 2012; Hoshyar et al., 2015; Vafaei and Abdollahzadeh, 2015; Safizadeh et al., 2016; Gheibi et al., 2018). On the basis of Iranian traditional medicine, local traditional healers used powders of stem bark and leaves of jujube to cure wounds and oral wounds as aphthous. Hamed et al. (2016) also discovered that fruits are widely used in Iranian folk medicine as antitussive, laxative agent and blood pressure reducer. Jujube fruit contains flavonoids, vitamins, amino acids, organic acids, polysaccharides, and microelement, which are found useful in spleen diseases and nourishment of blood in Chinese system of medicine. Tahergorabi et al. (2015) stated that different parts of jujube can be used for curing different kinds of diseases such as diabetes, diarrhea, skin infections, liver complaints, urinary disorders, obesity, fever, pharyngitis, bronchitis, anemia, cancer, insomnia, and for blood purification and tonification of the gastrointestinal tract. Hemmati et al. (2015) reported that jujube causes a decrease in the blood levels of glucose and lipids and it has been reported to make a significant decline in triglyceride, LDL and cholesterol levels. Mahajan and Chopda (2009) found that roots and the bark are used to treat dysentery. Recent phytochemi-

cal researches of jujube fruits have revealed their effects, such as the anticancer, anti-inflammatory, antiobesity, immune stimulating, antioxidant, hepatoprotective, and gastrointestinal protective activities and inhibition of foam cell formation in macrophages. They have also mentioned that jujube fruits are rich in bioactive compounds. Shi et al. (2018) indicated that the skin color of jujube fruit during maturation undergoes changes that reflect the changing levels of flavonoids, carotenoids, and anthocyanins. They concluded that the color changes are also associated with changes in antioxidant activity. Drying jujube guarantees a longer shelf time while preserving its quality to be used in medical and pharmaceutical industries. Taechakulwanijya et al. (2013) have found that all jujube seed extracts were not toxic to Vero cells, all jujubes cultivars tested are promising candidates for more elaborate study of their anticancer mechanisms. It has been reported that triterpenic acids were considered as active ingredients for the effect on anti-inflammatory and anti-cancer activities. Shahrahmani et al. (2018) showed that *Zizyphus jujube* fruit lotion can treat sore nipples faster than breast milk over a period of 10 days. Also, nipple pain in the jujube lotion group was less than the breast milk group. They have suggested that administration of high doses of jujube (up 5000 mg/kg) is nearly safe and did not exert hepato and nephrotoxicity in rats. Combination of *Zizyphus jujube* and green tea extracts exerts excellent cytotoxic activity in HepG2 cells via reducing the expression of APRIL; also, jujuba extract and green tea extract mixture might provide a lead to a new drug design to treat hepatocellular carcinoma in the future (Huang et al., 2009). Balakrishnan and Pamaiah (2013) found that methanolic extract of dried bark of *Zizyphus jujube* was found to cause a significant decrease in the levels of total cholesterol, triglycerides and LDL-cholesterol, and glucose levels in streptozotocin-induced diabetes in rats.

LOTUS

Lian (*Nelumbo nucifera*) commonly known as Lotus is an amazing aquatic perennial native to a large area spanning from Vietnam to Afghanistan. Lotus is a herbaceous perennial, belonging to Nelumbonaceae family of aquatic plants (Pal and Dey, 2013). Lotus seeds and roots are a major crop in Hubei, Hunan, Fujian, and Jiangxi provinces. In Chinese culture, its uses range from religious symbolism to tasty foods (Zhu et al., 2017). Lotus is popular among Asian countries as an economically important aquatic vegetable. On the basis of Chinese Medical herbology and pharmacology, the lotus and its various parts are among the most versatile herbs in traditional Chinese herbal medicine. Every part of the plant has separate and distinct properties. The most common names of the lotus in Chinese medicine are lian zi (lotus seed), Lian fang (lotus root receptacles) and lian ye (lotus leaf). This unique plant has special

properties in addition to being a powerful herb in Chinese medicine. The most important point about this crop is that, each part of the lotus plant has special uses such as the flower, the leaves, the stem, the rhizome, the seeds, the heart of the lotus seed and also its root.

Lotus composition and chemical constituents

Luo et al. (2016) reported that starch, protein and lipids, the major components in lotus seeds, affected taste and cooking properties of the food. The chemical compositions, gelatinization properties, crystal structure of the starch, compositions of fatty acids and soluble protein of lotus seeds, stored for 24 months, 12 months and as fresh were studied. The overall starch, protein and lipid contents in lotus seeds remained unchanged during storage, but structural changes occurred. The contents of amylose and free fatty acid increased significantly during prolonged storage, but the solubility of protein decreased dramatically. Lotus seeds energy chiefly comes from carbohydrates and protein unlike as in other tree nuts whose high calorific value is mainly because of fats. Varieties in the nutritional value and the organoleptic, therapeutic, and functional properties of the lotus are due to the varieties in the types, contents, and metabolic properties of the phenolic compounds (Limwachiranon et al., 2018). Nutritive value of lotus seeds is shown in Table 2. Per cent concentration of various elements of *Nelumbo nucifera* (seeds) is indicated in Table 3. Phytochemical analysis of *N. nucifera* seeds is presented in Table 4. Major chemical constituents present in *Nelumbo nucifera* seeds are shown in Figure 1.

Table 2. Nutritive value of lotus seeds (Indrayan et al., 2005).

Ash [%]	4.50
Moisture Content [%]	10.50
Crude Fat [%]	1.93
Protein [%]	10.60
Carbohydrate [%]	72.17
Crude Fibre [%]	2.70
Energy [cal/100 g]	348.45

Table 3. Percent concentration of various elements of *Nelumbo nucifera* (seeds) (Indrayan et al., 2005).

Chromium	0.0042
Sodium	1.00
Potassium	28.5
Calcium	22.10
Magnesium	9.20
Copper	0.0463
Zinc	0.0840
Manganese	0.356
Iron	0.1990

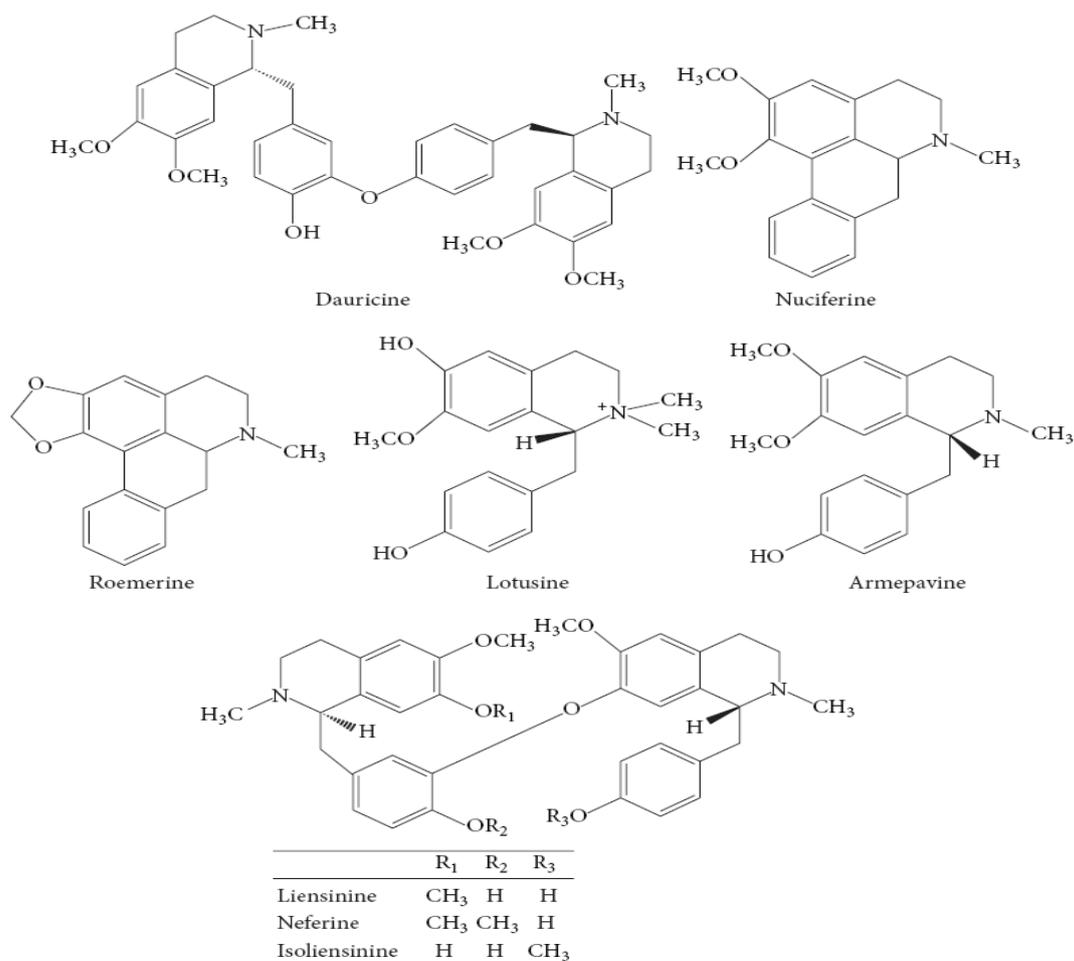


Figure 1. Major chemical constituents present in *Nelumbo nucifera* seeds (Paudel and Panth, 2015).

Table 4. Phytochemical analysis of methanol extract of *Nelumbo nucifera* seeds (Sujitha et al., 2013).

Chemical test	<i>N. nucifera</i>
Alkaloids	-
Carbohydrates	+++
Saponins	-
Proteins	+++
Phenolic compounds	++
Flavonoids	+
Tannins	-

(-) absent, (+) mild, (++) average, (+++) large

Lotus health benefits

All parts of the lotus plant are used: the rhizome is used as food, seed as medicine, thalamus as fruit, leaves as a meal dish, stalks as pickle, petals for colour extraction, and tender leaves as food after being blended with vegetables (Mandal and Bar, 2013). The seeds are roasted or candied for eating directly; made into a paste for producing sauces and cake fillings, and cooked in soups, usually with

chicken or beans. In the traditional Chinese medicine, lotus seeds and plumule occupy special therapeutic importance. Cao et al. (2018) found that lotus seed epicarp ameliorated obesity, insulin resistance and oxidative damage in obese mice, suggesting they are good candidates for value-added functional food and nutraceutical ingredients. Zeng et al. (2013) reveals that the lotus seed protein was nutritionally well-balanced protein and might be of significant importance in the formulation of diets for humans. Kim et al. (2018) stated that lotus seed increased the viscosity of the soy porridge as well as its antioxidant and antibacterial effects. Kim and Shin (2012) concluded that the high antioxidant capacity of lotus water fraction could be available as natural additive in food. Jeon et al. (2009) found that palmitic acid methyl ester clearly induced melanogenesis as the result of increased tyrosinase expression, thereby indicating that it may play a role in the regulation of melanin content. They reported that lotus flower oil may prove useful in the development of gray hair prevention agents or tanning reagents. Wang et al. (2012) noted that lysicamine extracted from lotus leaves may be a potential antibacterial and anti-inflammation agent for oral infection.

*COIX LACRYMA-JOBI***Coix origin and Coix nutritional composition and chemical constituents**

Coix lacryma-jobi L. is a distant relative of maize in the Maydae tribe of the grass family, Poaceae or Gramineae (Leseberg and Duvall, 2009; Chaisiricharoenkul et al., 2011). Its seeds are mainly produced in East and South-East Asia, including China, Japan, the Philippines, Burma, and Thailand (Bhandari et al., 2012). The current planting area in China is estimated around 73,000 ha with a grain yield of 0.22 million tons (Diao, 2017). It has higher protein content than other cereals that makes it a good source of nutrition for humans and animals (Capule and Trinidad, 2016). It is documented that *Coix lacryma-jobi* seed was found at the Hemudu site, indicating that *Coix lacryma-jobi* has been cultivated in China for more than 6000 years (Chen, 2003). This native of tropical Asia has long been cultivated for its bead-like seeds, resulting in it becoming widely naturalized throughout the tropical and sub-tropical regions of the world. Job's tears is a robust grass usually growing 1–2 m tall. Its upright stems are relatively thick and produce prop roots from their lower joints. The alternately arranged leaves are large (10–50 cm long and 2–5 cm wide) and have a stem-clasping base. These leaves are mostly hairless, but their margins may be fringed with fine hairs.

Coix health benefits

Hsu et al. (2003) reported that Adlay seeds have been used to treat warts, chapped skin, rheumatism and neuralgia, and it is an anti-inflammatory and -anthelmintic agent. Besides, a number of benzoxaziones in adlay seeds exhibit anti-inflammatory activity (Huang et al., 2009; Geetha et al., 2018). Numata et al. (1994) reported that adlay grains may have anti-tumor activity. Han et al. (2017) discovered that the compositions of proteins and polysaccharides of coix seed had the most effect in regulating the water transport of spleen deficiency. Das et al. (2017) reported that the chloroform extracts (leaves and seeds) showed efficacy for both bacterial infections and parasitic disease, which ensure the traditional uses of *Coix lacryma-jobi* L. Xi et al. (2016) revealed that the proportion of palmitic acid and linoleic acid to oleic acid displayed a highly significant positive correlation with the inhibition rates of Job's tears seed oil for T24 cells, and thus can be an important indicator for quality control for Job's tears. Root extract of *Coix lacryma-jobi* is commonly used for treatment of snake bites by traditional healers of south India, in particular coastal Karnataka (Rajesh et al., 2017). Son et al. (2017) stated that *Coix lacryma-jobi* inhibited migration, invasion, and adhesion of colon cancer cells and tube formation by HUVECs via repression of the ERK1/2 and AKT pathways under hypoxic conditions.

DRY LILY BULB (= LILY BUDS)

Origin, health benefits and constitution of lily bulb

Lilies are attractive economic flowering plants grown in pots or as cut flowers (Pobudikiewicz and Treder, 2006; Younis et al., 2014). Lily flower has long been used by many cultures as a symbol of tranquility, peace and prosperity. The Roman Catholic Church used lily flowers to symbolize the Virgin Mary and to represent its own state of independence and prosperity. The Chinese culture uses lily bulb to make desserts for festivities and weddings to symbolize good luck and longevity of marriages. Liliun is recognized as a valuable cut flower and many breeding companies are working on the development of new cultivars of the species belonging to different sections of genus (Lucidos et al., 2017). Lilies grow best in well-drained soil. Dry lily buds (huang hua) also known as golden needles and tiger lilies. Dried lily buds are among the most notable of edible flowers in Chinese cuisine. Dried lily bulbs are typically yellow-gold in color and are generally two or three inches long. They are also known to have a delicate flower, often described as musky, earthy and sometimes even sweet or slightly tart. Dried lily buds are used for their unique aroma which is fruity and flowery. Dried Lily flowers are used in Chinese cooking as a flavor enhancer, primarily in vegetarian dishes, but also in various stews and soups. The most important health benefits of lily bulb are shown in Figure 2.

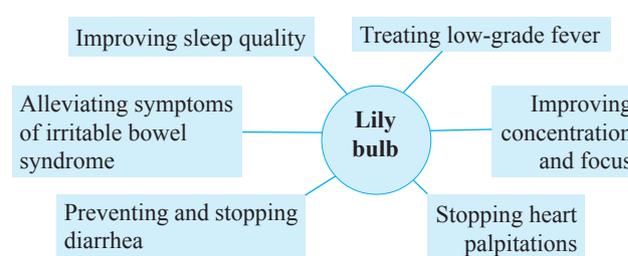


Figure 2. The most important health benefits of lily bulb.

TREMELLA

Origin, chemical constituents and health benefits

Tremella is a genus of fungi in the family Tremellaceae. Over 100 species of *Tremella* are currently recognized worldwide (Han et al., 2015). Two species, *Tremella fuciformis* and *Tremella aurantialba*, are commercially cultivated for food. It is rich in polysaccharides, triterpenoids, protein, dietary fiber, vitamins and chitin (Zhang et al., 2011). Tremella was one of the original genera created by Linnaeus in his Species Plantarum of 1753. The name

comes from the latin tremere meaning to temble (Liu and Wu, 2019). Linnaeus placed *Tremella* in the algae, including within it a variety of gelatinous growth, including seaweeds, cyanobacteria and myxomycetes as well as fungi (Ruan et al., 2018). *Tremella fuciformis* is one of the great superfood mushrooms and longevity tonic herbs in traditional Chinese medicine (TCM). In ancient times, like many of the other revered medicinal mushrooms such as Reishi and *Cordyceps sinensis*, Tremella was only reserved for royalty, ruling family members or for rich people who could afford this highly valued superfood (Wu et al., 2019). Tremella mushroom belongs to the jelly fungus family and has many different names. In Chinese, it is called silver ear mushroom, white wood-ear mushroom and in Japanese, it is called shiro kikurage which translates to white tree jellyfish. It is also commonly known as snow fungus, or the beauty mushroom. Tremella has been a popular staple of Chinese cuisine for centuries, rich in dietary fibers, protein,

minerals, antioxidants, and high in vitamin D. It is used in China in a variety of dishes from anti-aging soups to desserts. Tremella has traditionally been used by Chinese and Japanese herbalists as a potent Jing and Chi (Qi) tonic for thousands of years. It is believed to nourish the lungs, kidneys, heart, brain, stomach, and acts as a powerful tonic for the immune system. Tremella consists of lots of vitamin D, lots of protein, and also contain other vitamins, minerals, immune boosting polysaccharides, trace minerals, carbs, and a little fat (Kuo et al., 2012; Ohiri, 2017). Wang et al. (2015) reported that Tremella polysaccharides (TP) are the major component and activity unit of Tremella. Park et al. (2007) concluded that *T. fuciformis* might potentially be used as a precautionary agent in neurodegenerative disease, such as Alzheimer’s disease. Shen et al. (2017) indicated that *Tremella fuciformis* polysaccharide (TFPS) alleviated hydrogen peroxide-induced oxidative stress and apoptosis in skin fibroblasts via upregulation of SIRT1 expression, indicating that TFPS may act as a potential therapeutic agent for oxidative agent for oxidative-stress-associated skin diseases and aging. The most famous beauty and skin enhancing properties of Tremella mushroom is presented in Figure 3. Proven health benefits of Tremella is shown in Figure 4.

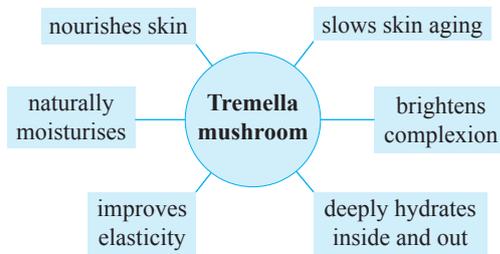


Figure 3. The most famous beauty and skin enhancing properties of Tremella mushroom.

SUMMARY

China is the home of traditional Chinese medicine. There is an ancient saying that food and medicine are from the same source, which is also the foundation of functional foods today. In recent years, China is one of the world’s most important and developed markets for functional fo-



Figure 4. Proven health benefits of Tremella mushrooms.

ods, which are based on traditional dietary culture and the rapid economic development among individuals and communities. Functional food is defined as a food that has special health functions and it is suitable for consumption by special groups of people and has the role of regulating human body functions but is not used for therapeutic purposes. The most important pharmacological properties of jujube are anti-diabetic effects, hypnotic-sedative and anxiolytic effect, neuroprotective activity, sweetness inhibitor, anti-cancer activity, anti-ulcer activity, anti-inflammatory effect, anti-spastic effect, anti-allergic activity, permeability enhancement activity, cognitive activities, anti-fertility, hypotensive and anti-nephritic effect, cardiovascular activity, immunostimulant effects, anti-oxidant effects and wound healing activity.

In Traditional Chinese Medicine (TCM), lotus roots are plants that belong to the 'Herbs that stop bleeding' category. Coix is a source of ornamental beads, a stable sustenance, and a productive fodder grass increasingly viewed as a potential energy source.

Lily flower has long been used by many cultures as a symbol of tranquility, peace and prosperity. Lily-bulb has three primary sets of active components: alkaloids (steroidal alkaloids, such as etioline as well as small pyrrolines like jatrophine, also called lilidine); steroidal saponins; and phenols (mainly flavonoids). Lily bulbs are used to relieve coughs, dry throats and other respiratory conditions, to clear away heat, and to treat insomnia and heart palpitations. Its tonic properties make it a good herb for promoting restful sleep and treating restlessness and irritability. Lily bulb provides protein and starch. Additionally, they contain small amounts of calcium, iron, phosphorus and vitamins B1, B2 and C. In traditional Chinese medicine, lily bulb is considered sweet and cooling in properties. The herb is also associated to the lung and heart meridians and help to relieve coughs, dry throats, clear heat, and moisten the lung.

Tremella has been a popular staple of Chinese cuisine for centuries, rich in dietary fibers, protein, minerals, antioxidants, and high in vitamin D. Tremella has traditionally been used by Chinese and Japanese herbalists as a potent Jing and Chi (Qi) tonic for thousands of years. Tremella has been clinically used to help clear heat and dryness, replenish fluids in the body (Yin deficiency), to treat chest congestion, asthma, constipation, balance blood sugar levels and cholesterol (reduces LDL), and lower inflammation.

Traditional Chinese Medicine included fruits and herbs are increasingly and extensively used by a substantial part of the population. Jujube has numerous important pharmacological activities and it can be considered as a valuable source of nutraceuticals.

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received – 20 July 2020
revised – 20 October 2020
accepted – 16 December 2020



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